UTILIZATION OF MILL RESIDUES IN THE TIMBER PRODUCTS MILLS OF THE LAKEVIEW WORKING CIRCLE

RESEARCH PAPER NO. 6

U.S. DEPARTMENT OF AGRICULTURE · FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
R. W. COWLIN, DIRECTOR
PORTLAND, OREGON JUNE 1953

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Introduction

The manufacture of lumber from logs is always accompanied by the accumulation of wood fiber in the form of sawdust, slabs, edgings, trim, and shavings which is of little commercial value. Sawmills use a portion of this "residual" wood fiber for generating steam with which to run the mill and dry kilns, some is used as a raw material for other industries, but much of it is still disposed of in burners.

The industrial economy of lumber-producing communities is dependent on a continuously adequate timber supply. Lakeview in Oregon is such a community. Foreseeing a decreasing timber supply and consequent decrease in sawmill employment, the local Chamber of Commerce began to explore the possibilities of generating new industries to provide new jobs and thus maintain the present level of employment. This could be done in two ways: (1) added employment might be provided through more complete manufacture of the lumber produced in Lakeview, or (2) it might also be provided by producing new products using the present type of mill residue (waste wood) at the lumber mills as a raw material. In either case the first step of exploration would be to determine how much and in what forms mill residue is being developed at the lumber mills and how much of it is already being used.

In 1949 the Lake County Chamber of Commerce contributed funds which enabled the Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service to make a study of the volume of mill residue in the lumber industry in that area. Sinclair Wilson visited the Lakeview mills and determined the mill residue volume for the 1948 lumber production. In January 1952 a review was made of current sawmilling practice and new volumes were determined. These results, combined with those for 1948 were projected to apply to future operations when the lumber production in the area might be limited to the log supply coming only from Forest Service timber sales in the Lakeview Federal Unit, aggregating about 50 million feet per year.

This report describes how the study was conducted and shows the volume and kind of mill residue being developed. It also discusses several kinds of new products now being made elsewhere in this country from wood fiber, which might be considered for manufacture in the Lakeview and other lumber-producing communities as potential new industries using mill residue wood fiber as a raw material.

Method of Study

In 1949 the lumber-producing industry in the Lakeview area, consisting of four sawmills and three remanufacturing plants, was visited by Sinclair Wilson. By interviewing mill personnel and observing plant operations, he analyzed the cutting practice, manufacturing equipment, power-plant fuel use, and waste disposal at each plant. In the sawmills he measured the size and volume of typical logs and the dimensions of each board cut from the logs. He measured the thickness of the saw kerf and the set-out at the log carriage. By diagramming the log cross-section and plotting the position and size of each cut and each board, he calculated the volume of the wood in the log, and then in the rough lumber--the slabs, the edgings, the sawdust, and the trim. Similarly, he extended his calculations to measure the volume of bark on the log and the portion which became sawdust and which adhered to the slab and edgings. He also measured and closely estimated the volume of mill-residue material passing over the various conveyors. By similar observations he determined the amount of wood fiber developed in planing the lumber to finished size, in remanufacturing to moldings, and in producing box shook.

Using this information, and drawing upon his wide experience in lumber manufacture, Wilson calculated in unit volumes the amount of residual wood and bark developed by type of product; that is, sawdust, slabs, edgings, trim, and shavings at sawmill, planing mill, molding plant, and box factory. These values he expressed in terms of cubic feet (wood fiber as found in log form) per thousand feet of log scale (board measure) cut at the sawmill, and in cubic feet per thousand feet board measure (lumber tally) of lumber brought into the remanufacturing plant.

The disposition of the mill residue was also determined. The solid volume of wood and bark used by the mill for its own power and for power sold; the volume sold for domestic fuel, box cleats, and other uses; and the volume burned or otherwise destroyed were developed in the same units and terms as those which were used in calculating the volume of mill residue.

These values, determined at each sawmill and remanufacturing plant, were consolidated to show a total for the area, based on the lumber production for the year 1948. In January 1952 current sawmilling practice in the area was reviewed and the 1948 results were modified and extended to the 1951 lumber production under the current Lakeview Federal Unit of the Forest Service, which now adds the production of a sawmill at Paisley to the Lakeview group. Estimates were also made for the amount of wood waste which would be expected to develop several years hence if the lumber

production in the area were limited to a log supply available only from Forest Service sales aggregating approximately 50 million feet a year in the area embraced by the present Federal Unit. It was recognized, however, that changes in the Federal Unit provision and in utilization practice would directly and materially affect such residual wood estimates.

Mill Residue Produced in Lakeview

The sawmills and remanufacturing plants in the Lakeview area are typical modern operations of medium or small size. Bandsaws are used in the sawmills, highly efficient forced-circulation dry kilns are used for drying the lumber, modern planers are used in remanufacturing plants, and the box factory is fitted with resaws with minimum thickness of saw kerf. Altogether, the manufacturing practice in Lakeview may be considered as representing efficient utilization of the log according to current industry standards. There is no indication that the volume of mill residue developed in sawing and finishing lumber is greater than customary for the industry generally.

The results of this study, shown in table 1, combine the volume of residual wood developed at all of the mills in the area. The 1948 cut of the sawmills amounted to 49 million board feet (log scale). These logs are calculated to have contained 7,250,000 cubic feet of sound wood (not including bark). The volume of wood products (lumber, millwork, moldings, box shook) produced from these logs and shipped from Lakeview was calculated to be 3,422,000 cubic feet or 47.2 percent of the wood fiber content of the log.

In the sawmills the wood fiber in the sawdust, slabs, edgings, and trims amounted to 2,316,000 cubic feet or 30.2 percent of the log volume. The planing mills received directly only two-thirds of the production of the sawmill, the balance going directly to molding and box plants, or being sold rough. In the planing mill, however, the additional loss of wood fiber represented 8.1 percent of the volume of the log. Molding plants and box factories use both planed and rough lumber, and it is not possible to accurately measure the portion of the log developed as waste material here. For both types of plants, however, the residual fiber would amount to the remaining 14.5 percent--making a total mill residue of 52.8 percent of the volume of sound wood in the log brought to the sawmill. The volume of bark was calculated at 1,370,000 cubic feet or equal to 18.9 percent of the volume of wood contained in the logs.

The volume of mill residue for 1951 was greater than in 1948 because of the increased volume of logs processed by the industry. However, the percentage of residual wood was considered to be the same in each type of plant. A smaller percentage of the lumber production was processed in the molding plants and box factories; consequently, the increase in mill residue was somewhat less than would be indicated by extending the 1948 values. This effect is also reflected in the values calculated for the future federal unit operation, when the available log volume is estimated to equal the 1948 value, but molding plants and box factories will process less lumber and consequently develop less residue.

Table 1.--Mill residue produced at wood-using plants of Lakeview area

Type of plant and raw material	Volume through plant	Volume of mill residue developed							
		Sawdust		Slabs, edgings, trim		Shavings	Total	
		Bark	Wood	Bark	Wood	Wood	Bark	Wood
	Thousand bd. feet	Thousand cubic feet						
1948 Production:								
Sawmill, logs	49,000	106	978	1,264	1,338		1,370	2,316
Planing mills, lumber	32,500		54		66	300		420
Molding plants, lumber	16,500		117		170	420		707
Box factories, lumber	19,000		136		213			349
Cut stock, lumber	1,500				36			36
		106	1,285	1,264	1,823	720	1,370	3,828
1951 Production:								
Sawmill, logs	72,511	132	1,268	1,690	1,731		1,822	2,999
Planing mills, lumber	51,418		86		182	562		830
Molding plants, lumber	15,200		75		97	257		429
Box factories, lumber	15,500		107		171			278
		132	1,536	1,690	2,181	819	1,822	4,536
Estimated future federal unit operations:								
Sawmill, logs	50,000	92	874	1,152	1,185		1,244	2,059
Planing mills, lumber	35,480		57		114	255		526
Molding plants, lumber	10,480		40		51	141		232
Box factories, lumber	11,200		87		90			177
		92	1,058	1,152	1,440	596	1,244	2,994

Tables 2 and 3 recapitulate the mill residue values shown for 1948 in table 1 and also show the amount per thousand board feet, log scale. In 1948 the steam boiler plants used 2,510,000 cubic feet of wood and 688,000 cubic feet of bark for fuel (table 4). This amounts to two-thirds of the wood fiber and one-half of the bark developed as mill residue at all of the mills and remanufacturing plants. Logs were sawn in four sawmills. Lumber was finished and remanufactured in three planing mills, three molding plants, and three box factories. Steam to serve all of these operations was produced at four boiler plants--all rather old and less efficient than new ones. Except for a small amount sold for domestic fuel (11 percent of the total) the remaining residual wood was sent to the burner and served no useful purpose. The volume thus destroyed was largely wet bark and sapwood slabs--of least value for fuel--or residual wood developed at remanufacturing plants too remote from the steam boiler plant to permit economical transportation to the boilers.

Uses for Mill Residue

The primary use of mill residues in the Lakeview area is for fuel in steam boiler plants at the sawmills and remanufacturing plants. Large quantities of steam are needed to provide power in the mill and to heat the kilns in which lumber is dried. All forms of mill residue can be used for fuel, but material containing a large amount of water is less efficient. Pine logs are relatively high in water content and consequently produce wood fuel less suitable for generating steam than is the case for much of the log volume manufactured into lumber in the Douglas-fir area. Further, the high water content of the green pine lumber requires a greater volume of steam for heating the dry kilns to dry the lumber. Air drying is sometimes practiced to remove a part of the moisture from the lumber before loading it into the kilns to complete the drying. This enables kiln drying the lumber with less steam requirements.

The amount of residual wood sold for domestic use in Lakeview is small. Sawdust-burning furnaces are few and there is no prospect that the heating of the houses would provide any substantial market for the present type of mill residue produced at the mills.

In evaluating processes which would utilize residual wood for products more valuable than fuel for steam boilers, one must rate its value as fuel in the plant where it is produced. When residual wood is withdrawn from a boiler plant and is replaced by oil, current practice and prices indicate that as much as $5.25 worth of oil may be needed for each unit of dry residual wood replaced. Sawdust and shavings developed in the process of surfacing dry lumber have a high fuel value. Wet bark, sawdust, and hogged fuel from a pine sawmill have low fuel value in a boiler plant. At the present time residual wood used as fuel in Lakeview is probably rated as having no commercial value, since there is no market for the excess supply, which is now disposed of by burning. But if residual wood were utilized to such an extent that oil were needed in the boiler plant, the residue would rate a substantial market value equivalent to the oil required to replace it.

Table 2.--Solid volume of mill residue (wood and bark) developed annually at sawmills in Lakeview area, Oregon - Base year 1948

(Total logs to mills -- 49,000,000 f.b.m. log scale)

Item	Mill residue[1/]	
	Total volume produced	Volume per thousand board feet of logs (log scale)
	M cubic feet	Cubic feet
Bark-free wood:		
Slabs and edgings	1,126	22.9
Trim	214	4.4
Sawdust	978	19.9
Bark:		
On slabs and edgings	1,264	25.8
Sawdust	106	2.2
Total	3,686	75.2

1/ One cubic foot of mill residue is considered as one cubic foot of solid wood.

Table 3.--Solid volume of mill residue (wood) developed annually at remanufacturing plants, Lakeview area -- Base year 1948

(Total lumber remanufactured 46,500,000 f.b.m.)

Item	Mill residue[1/]	
	Total volume produced	Volume per thousand board feet of logs (log scale)
	M cubic feet	Cubic feet
Edgings and trim	485	10.4
Sawdust	307	6.6
Shavings	720	15.5
Total	1,512	32.5

1/ One cubic foot of mill residue is considered to be one foot of solid wood.

Table 4.-- Summary -- utilization of mill residues produced annually in Lakeview area

(Base year - 1948)

Type of plant and residual material	Fuel power plant		Fuel domestic sales		Destroyed		Total	
	Bark	Wood	Bark	Wood	Bark	Wood	Bark	Wood
	Thousand cubic feet							
Sawmills:								
Sawdust	106	978					106	978
Slabs, edgings, trim	582	816		107	682	415	1,264	1,338
Planing mills:								
Sawdust		54						54
Edgings and trim		50		16				66
Shavings		300						300
Molding plants:								
Sawdust		15				102		117
Edgings and trim				133		37		170
Shavings		103				317		420
Box factories:								
Sawdust		136						136
Edgings and trim		58		155				213
Cut stock plant:								
Edgings and trim				36				36
Total	688	2,510		447	682	871	1,370	3,828

Possible Uses for Sawdust and Shavings

There are three possibilities for using sawdust and shavings produced at Lakeview for the manufacture of new products. First, shavings can be reduced in size by a hammermill and used with sawdust to produce fuel briquets. The moisture content of the mixture, when briquetted, should be approximately 7 percent to prevent a steam explosion of the briquets, for considerable heat is generated in the process. Examples of this product are the Pres-to-logs and Stoker Fuel produced by Potlatch Forests, Inc., at Lewiston, Idaho, and the wood pellets under development by several equipment manufacturing companies. Such products have a ready market in most localities where they have been produced. Dry shavings and sawdust from a planing mill, molding plant, and box factory could be used directly for the production of Pres-to-logs. One Pres-to-log machine operating continously, will produce 10 tons per 24-hour day. This production would use 840 cubic feet of pine wood material (solid measure as reported in table 2) per day or 210-thousand cubic feet per year, assuming 250 working days. If it were possible to divert all dry shavings and sawdust not utilized for fuel in Lakeview plants to a single Pres-to-log production plant, there would be available a total of 909 thousand cubic feet per year, or enough to supply four Pres-to-log machines.

A second possibility is to use sawdust and shavings as the raw material for hardboard--a dry-form particle board. Two small hardboard plants operating in the Midwest--Rock Island Lumber Company and Curtis Industries, Inc.--use ponderosa pine sawdust and shavings from their millwork plants for making the board. They have pooled their technical knowledge and the process may be licensed for manufacture in other areas. Six dry-form hardboard plants producing a different type of board are currently under development, construction, or in limited operation in the Pacific Northwest. Primarily, they use Douglas-fir as the raw material although other species, such as lodgepole and white fir, are entirely suitable. There is an expanding market for hardboard and it has many uses, such as door panels, kitchen cupboards, furniture, core material, plywood faces, flush doors and wallboard.

Finally, when dry and properly screened and sized, sawdust is suitable for the production of fur-cleaning compounds, metal-tumbling, floor-sweeping compounds, and insulation.

Using Slabs, Edgings, and Trim

The larger pieces of unused wood--slabs, edgings, and trim--can be approached from another angle, and this material is the key to major development of an integrated utilization center. The material can be manufactured into commercial items by processes familiar to the lumber industry. Then only conventional equipment such as rip-and-trim saws and planers are required. The end product is called cut stock. The cut stock industry is not new to the Lakeview area.

Though the industry has some pitfalls, the transition to this type of utilization is relatively easy for sawmill and remanufacturing plants. Products such as toy stock, cleat stock, and millwork parts have at various times had a ready market. In general, this type of utilization creates additional employment with the least capital outlay for equipment.

The major problem to be solved, then, is marketing the cut stock. A possible answer is a cooperative organization with the sales office on the Mississippi River and technical sales representatives to service customers' needs. Another possibility is gluing cut stock into larger sizes for use as cores, millwork parts, and similar products. Such glued and laminated products are utilized in other sections of the country by facing them with high grade veneers for the production of furniture.

Bark-free slabs, edgings, and trim obtained from the sawmill can be reduced to chips and converted into softboard or hardboard. (Dry wood from planing mill, molding plant, or box factory does not lend itself readily to chipping.) Green wood chips can be defiberized and a wet-form process can be used to produce the board. Wet-form board plants require an adequate water supply and satisfactory disposal of the effluent. A wet-form hardboard plant requires a higher capital investment than dry-form hardboard plant of the same capacity but may produce board at less total cost.

Sawmill slabs and edgings usually contain bark as they emerge from the mill. Setting up a plant at Lakeview to produce board (soft or hard) from defiberized wood would require the selection of bark-free wood or cleaning off the bark for most processes. However, one wet-form hardboard process uses Douglas-fir sawmill residue just as it comes off the waste conveyor without removing the bark, and a commercial plant is now in production. Other softwood species are also reported to be satisfactory for use by this modified process, but no commercial plant has demonstrated the statement. Several wet- and dry-form hardboard processes are available for licensing. The engineering of the plant as well as assistance in bringing the plant into operation will be furnished by the licensor.

Hardboard plants now in operation in the Douglas-fir region each produce from 100-thousand to 200-thousand square feet of 1/8-inch board per day. These plants use approximately 800 pounds of wood, dry weight, to produce 1000 feet of hardboard. On this basis they require 3000 to 6000 cubic feet of wood per day. Operating 250 days per year, the plants would require 750 thousand to 1½ million cubic feet of wood annually.

The total amount of wood material in the green slabs, edgings, and trim developed annually in all the sawmills in Lakeview amounts to 1,338,000 cubic feet--about enough to supply one large hardboard plant. Much of it, however, is used as fuel for the steam boilers. Currently, only 415,000 cubic feet of this material is being disposed of in waste burners as excess material. This volume is less than one half of that required to supply a 100-thousand-foot hardboard plant.

Still another possibility is pulp production. There is enough material in the Lakeview area to supply a pulp mill--including logging residues, tree species not now utilized, and present manufacturing residues. But water requirements and effluent disposal are difficult problems. A thorough investigation of these two problems should be considered first, since the smallest economical size of a kraft pulp mill is considered to be about 200 tons of pulp per day. A table of water requirements for wood processing plants is attached to this report (table 5).

Finally, there are other chemical processes for utilizing residual material. These include manufacture of such products as molasses and yeast for stock and poultry feeds, and charcoal. Sufficient data now have been obtained to give the technical basis needed for the construction of commercial molasses or yeast plants, but considerable additional development work needs to be done to determine true manufacturing costs and market acceptance of these products. The market development for a new product is a major undertaking; experimental feeding tests already made, however, prove the suitability of molasses and yeast for stock and poultry feed. Charcoal production is needed in the Pacific Northwest. Currently, this market area consumes 45 thousand tons of charcoal per year and West Coast production is confined to a small amount of charcoal which is produced in a few pit burners. The production of charcoal is usually a marginal operation. Several processes are available and new ones are being studied. As a scavenger operation using all of the residual wood material not suitable for other products, a charcoal plant could be an asset in an integrated utilization center.

Full utilization provides an opportunity to increased employment. The magnitude of this opportunity is summarized in a report[1/] prepared by Ralph W. Marquis, while he was a member of the Pacific Northwest Forest and Range Experiment Station, and is presented in table 6. The tabulated values are additive. For example, in the manufacture of dressed lumber the man-days required in the woods, in the sawmill, and in the planing mill would be added together to get the total employment needed to produce a million feet of surfaced lumber. While this discussion is not a blueprint for industrial expansion, it may serve to stimulate ideas concerning the development in Lakeview--or any other similar community--of an integrated utilization center based on a known raw material supply. This type of development seems a promising way to expand industry.

Summary

During 1948 the Pacific Northwest Forest and Range Experiment Station, in cooperation with the Lakeview Chamber of Commerce, conducted a study to determine the amount and type of mill residue material developed annually at lumbering and remanufacturing plants in the Lakeview area. This information was sought as a basis for possible expansion of wood-product industries in that area.

1/ Marquis, Ralph W. Employment opportunities in full forest utilization. Journal of Forestry Vol. 46 (5): 334-339. May 1948.

Table 5.--Estimated water requirements for wood processing industries

Product	Daily production	Daily wood consumption[1]	Water requirements					
			For processing			Consumption[2]		
	Tons	Cu. ft.	Gal. per ton[3]	Gal. per day	Cu. ft. per day	Gal. per ton	Gal. per day	Cu. ft. per day
Sulfite pulp, unbleached	100	16,700	50,000	5,000,000	670,000	4	400	55
Sulfite pulp, bleached	100	18,000	95,000	9,500,000	1,270,000	[4]	[4]	[4]
Kraft pulp, unbleached	100	16,700	35,000	3,500,000	470,000	4	400	55
Sulfate pulp, bleached	100	18,000	92,000	9,200,000	1,230,000	[4]	[4]	[4]
Groundwood pulp	50	4,100	10,000	500,000	67,000	314	15,700	2,100
Hardboard, wet form (batch process)	20	1,800	2,500	50,000	6,700	235	4,700	630
Hardboard, wet form (continuous process)	30	2,700	10,000	300,000	40,000	235	7,050	950
Hardboard, dry form	Minor water requirements mainly steam for presses							
Insulation board	175	16,000	8,000	1,400,000	190,000	235	41,125	5,500
Alcohol (process water)	11,000	18,000	[5] 2,250	500,000	65,000	[4]	[4]	[4]
Cooling water at 60° F.	gal.		[5] 8,000	1,750,000	230,000			
Molasses (process water)	200	18,000	2,000	400,000	53,500	[4]	[4]	[4]
Cooling water at 60° F.			11,000	2,200,000	293,000			
Yeast (process water)	45	18,000	14,000	730,000	97,500	[4]	[4]	[4]
Cooling water at 60° F.			50,000	22,500,000	3,000,000			
Lumber (sawmill)	One gallon per board foot of production							

1/ Wood estimated at 24 pounds per cubic foot moisture-free weight, green volume.
2/ Water in product or otherwise lost; estimate based on the use of green wood.
3/ Per ton of product unless otherwise noted.
4/ Slight gain if green wood is used.
5/ Per ton moisture-free wood used.

Forest Products Laboratory
Madison, Wisconsin
July 11, 1951

Table 6.--Summary of employment under current and full utilization

Kind of labor	Number of employees	
	Present utilization	Full utilization
Logging (sound volume	3,400	7,068
Primary manufacture	4,653	6,844
Remanufacture of lumber	2,647	3,690
Remanufacture of pulp	840	3,627
Use of sawmill waste	75	1,500
Total	11,615	22,729

NOTE: Labor requirements per unit of annual production, used by Marquis in arriving at these employment figures, are:

Industry	Men needed
Logging	3.4 per MM feet
Thinning	5.0 per M cords
Rough lumber	3.25 per MM feet
Pulp	3.65 per M tons
Plywood	5.44 per MM square feet
Shingles	0.63 per M squares
Planing mill	1.75 per MM feet dressed
Box	7.50 per MM feet used
Millwork	15.00 per MM feet used
Furniture	80.00 per MM feet used
Caskets	10.00 per MM feet used
Paper	7.25 per M tons

With an average annual sawlog cut of 49 million board feet, the total yearly sawmill residue amounted to 2,316,000 cubic feet of clean wood and 1,370,000 cubic feet of bark. Approximately 46,500,000 board feet of the lumber produced was put through a planing mill or other remanufacturing plant. This remanufacture produced an additional 1,512,000 cubic feet of bark-free residual wood. Total mill residue amounted to 5,198,000 cubic feet, of which 3,828,000 cubic feet was sound wood fiber material. Total wood products shipped from Lakeview was calculated at 3,422,000 cubic feet, or 47.2 percent of the 7,250,000 cubic feet of sound wood contained in the logs entering the mills. Two thirds of the mill residue was used as fuel at the plant, 11 percent was sold as domestic fuel, and the remainder was disposed of in the burner or otherwise destroyed.

A review of the 1951 production for the Lakeview Federal Unit area shows a greater development of mill residues than in 1948 because the sawmill cut was 72,510,000 feet of logs compared to 49,000,000 in 1948. The 1951 cut, however, includes a sawmill at Paisley, about 25 miles from Lakeview and not studied in 1948. Mill residue from this plant would not be considered available as a raw material for a utilization plant in Lakeview except at considerable cost. In the foreseeable future, when the log supply in this area (including Paisley) might be limited to about 50 million board feet cut from the national forest, the amount of mill residue available in Lakeview as raw material for additional industries would be less than the amount shown for 1948. The volume of mill residues could readily be expanded, however, by bringing in, whenever it is economical to do so, lower grade material now left in the woods.

Uses for this residual material are many. Much of the material is currently used for generating steam power at the plants in the Lakeview area. Hogged fuel has a fuel replacement value of up to $5.25 per unit in comparison with present fuel oil costs. Modernization of the boiler plants would make it possible to generate the required power with less hogged fuel than is currently being used.

The mill residues not needed for the boiler plants could be used for the production of fuel briquets, hardboard, insulation, and a variety of other products, such as sweeping and cleaning compounds and charcoal. Production of kraft pulp and even molasses and yeast for stock feed offers other possible outlets if the problems of industrial water supply and disposal of effluents can be solved.

The cost of installing pulp mills, molasses, and similar plants is high. Therefore, it appears that the logical first improvement in utilization is to manufacture products requiring small plant investment. Using the larger sizes of mill residues--slabs, edgings, and trim--to produce a product familiar to the lumber industry offers the easiest opportunities. Products such as toy stock, cleat stock, and furniture and millwork parts can be produced with but little additional equipment in the present lumber-producing plants. Employment opportunities can be increased considerably through further remanufacture of the lumber.